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Agricultural Memorandum No. 906

SPRING WORK DAYS - A METHOD OF PREDICTING MONTHLY TOTALS FROM MONTHLY RAINFALL IN S E ENGLAND

Introduction

The variability of the British climate presents both risks and uncertainty to the farming community.

The number of days available for specific farm operations during certain times of the year is of great interest to the farm manager. Such information is useful for both the forward planning of work and also for decisions regarding machine capacity.

Earlier memorandum (nos. 168, 182, 211) were concerned with the time available for fieldwork in the spring, calculated from values of daily rainfall for 35 farms in the E. Midlands. These memorandum predicted the days available under light, medium and heavy soils; the criteria for light soils are shown in Appendix I. These criteria appeared to give reasonable results but their usefulness is limited because they relate to total available work days rather than to the days available for specific jobs, many of which will have fewer days than the total. To overcome this limitation, Westlake extended the light land criteria (based on Gleadthope EHF data) to cover the whole year and to predict for various groups of jobs whose weather requirements for success are similar. Appendix 2 shows the grouping of operations while Appendix 3 shows the criteria for assessing suitable work days. Both Smith and Westlake's methods predict the 'potential' available work days ie. the total number of days on which fieldwork could be carried out rather than number of days actually worked. The results of Westlake's criteria have not been applied to stations outside the E. Midlands and this is one field which could be investigated.

The problem with all surveys of this type is to obtain accurate farm data; the likelihood of developing a model to predict work days which match up to the subjective decisions of the farmer on a day-to-day basis is very remote indeed. It is the belief of the author that, in the absence of appropriate soil water models, etc, one can only hope to achieve predictions of monthly totals of work days and, to this end, monthly values of meteorological variables should be sufficiently accurate for this purpose. This memorandum outlines a method for estimating the days available for three broad job categories (see below) using a factor derived from the monthly total of rainfall.

Data

Records from eleven farms in the S E of potential work days (recorded daily) under light, medium and heavy soils were available from 1974 onwards* (although only 5 stations had complete records during this period). Each farm was designated either light, medium or heavy by a soil scientist according to the broad characteristics (ie. texture) of the soils in the surrounding area. This generalisation masks the often marked variations in soil type across a farm but one feels that there is little else that can be done. Field operations were grouped into three categories depending upon their sensitivity to the weather:

* Data part of an on-going survey by the Farm Management Dept., MAFF, Coley Park, Reading into the days available for fieldwork in the S E Region.

Group A: critical, weather sensitive, operations possible
eg. drilling, spraying, hay-making and combining.

B: essential seasonal work more tolerant of the weather possible
eg seed-bed preparations, silage making, straw carting and
root harvesting.

C: normal seasonal fieldwork possible eg. ploughing

An example of the monthly return is given in Appendix 4; the actual monthly values for all eleven farms from 1974-79 are given in Appendix 5.

Comments on the data

Only those farms with almost complete records from 1974 onwards were used in the analysis. The monthly totals of days for each farm were cross-checked with farms of similar soils for consistency; this check resulted in several 'anomalous' values whose records differed greatly from other farms in the survey. It was intended that the farmer should complete the form at the end of each day while the day's work was fresh in the mind, stating whether or not work was carried out. It became apparent from looking at the returns that they were often filled in at the end of each week, or even each month, the farm diary acting as an 'aide memoire'.

The subjective nature of this data is a major problem; each farmer will have their own opinion as to whether or not work will be possible on any given day and this decision in-turn will be influenced by non-meteorological factors eg. the type of machinery at the farmers disposal. Elementary checks were made of the equipment available at each site to eliminate the obvious advantages of low ground pressure vehicles, aerial spraying etc. on the frequency of work days.

Another major disadvantage is that the returns are not sufficiently definitive with incompatible jobs being included within the same group eg. spraying in Group A requires relatively low wind speeds while hay-making is perhaps dependent on a stronger wind to dry out the swath.

Application of Smith's criteria to the data

It was considered worthwhile to see if Smith's criteria bore any relationship to the raw data used in this survey. The problem with Smith's method is that it predicts total days available which infers a 'nesting' of days ie. any work day could be suitable for carrying out a number of operations. Looking at the classification of groups A, B and C, nearly all days in group A can be nested within group B (ie. nearly all days suitable for work in A will also be suitable for work in B) while many of the days suitable in group C could be nested within group B. Group B was therefore taken as the job category most likely to correspond to Smith's prediction of total days; the average monthly difference between group B records and Smith's method over the period 1974-78 for the months February to May for six sites are shown in Table 1.

Table 1

Average monthly errors* using Smith's criteria as an estimate of days available for work in group B

\+ values indicate an over-estimate by Smith's criteria

\- " " " under- " " " "

H: heavy soil M: medium soil L: light soil

Station	Soil	Average error (1974-78)				
		Feb	Mar	Apr	May	Feb - May
Dene Park	H	-16.5	-12.0	-6.5	-2.5	-38.0
Wye College	H	- 4.0	- 2.0	-5.5	-4.0	-15.0
Home Farm	L	- 3.0	- 1.0	-1.0	-1.0	- 7.5
Wye College	L	1.5	3.0	1.5	2.0	2.5
Hadlow College	M	2.0	5.5	-2.5	-0.5	4.5
Aylesbury	H	3.0	1.5	0.0	7.0	11.0

* All errors are rounded up to the nearest half day.

The results show that the spring estimates (Feb - May) are likely to be accurate to within ± 10 days of the actual group B value. The unusually high values recorded at Dene Park Farm were a result of the farmer considering work within a well drained orchard using small tractors and are therefore not representative of a 'typical' farm. The largest discrepancies occurred for heavy soils while the light land figures showed very good agreement. One can tentatively suggest, from the limited data analysed, that Smith's criteria could be used to predict the days suitable for fieldwork in group B.

The method of using monthly rainfall values for predictions of days in groups A, B and C is discussed below.

Method

Attempts to relate monthly work day totals to the number of wet days (greater than 1 mm/day) during the month proved unsatisfactory, as did a similar analysis using just monthly rainfall.

The spread of rainfall is very important eg. 2.5 mm rainfall per day for 10 days is likely to be more prohibitive to work than is a fall of 25 mm on one day. A monthly factor was calculated to account for this distribution where

$$\text{factor} = \frac{\text{monthly rainfall total (mm)}}{\text{number of wet days}}$$

- a wet day is defined to be one on which more than 1 mm of rain has fallen or on which there was a complete or partial covering of snow at the nearest climatological station at 0900 GMT. Throughout the analysis the nearest suitable rain gauges were used.

A linear regression analysis of factor against work days in groups A, B and C

over the spring for stations of similar soil type (ie light, medium or heavy) gave very poor correlations probably because factor takes no account of the increasing daily potential evaporation through the spring. Repeating this technique for individual months failed to improve the results and would perhaps indicate that difference in soil structure between farms is important although it is more likely that the subjectiveness of the data is to blame.

It was found in the end that good correlations could only be obtained when the regression was done for individual farms and months, and the results are given below.

Results

The sample correlation coefficients r between factor and work days are shown in Table 2.

Table 2

Correlations between factor and work days for groups A, B and C

Station	Soil	Correlation coefficient r											
		Feb			Mar			Apr			May		
		A	B	C	A	B	C	A	B	C	A	B	C
Wye College	H	0.84	0.95	0.62*	0.76	0.96	0.96	0.88	0.97	0.81	0.97	0.58	0.75
Wye College	L	0.71	0.71	0.26	0.84	0.98	0.94	0.94	0.99	0.82	0.92	0.49	0.71
Dene Park	H	0.89	0.72	0.46*	0.91	0.93	0.90	0.85	0.96	0.79	0.91	0.87	0.63
Hadlow College	M	0.59	0.87	0.84	0.73	0.91	0.56	0.94	0.95	0.74	0.55*	0.85	0.83
Hants College	L	0.53	0.46*	0.50*	0.69	0.71	0.52	0.56*	0.48*	0.20*	0.41*	0.37	0.14*

* low correlations because of one, or at most two, 'anomalous' values.

In 9 out of 10 asterisked values omitting the 'odd' value returned correlations $\geqslant 0.8$, of which 4 were $\geqslant 0.9$. Replacing these corrections in Table 2, over 80% of r values are $\geqslant 0.7$, over 60% are $\geqslant 0.8$ and over 30% are 0.9. The regression equations (after omitting 'odd' values where applicable) are given in Appendix 6 while Figs 1(a) to 1(d) show the scatter diagrams for Wye College, Feb-May).

From the 5 years of data analysed, a return of $r > 0.878$ at the .05 probability level is necessary for a linear relationship to exist. Thus approximately only 40% of the correlations are statistically significant. Furthermore, the proportion of variance of work days attributed to its linear regression on factor equals r^2. The values of r^2 corresponding to Table 2 are shown in Table 3.

Table 3

The estimated proportions of the variance of work days associated with factor in a linear regression

Station	Soil	r^2 Feb			Mar			Apr			May		
		A	B	C	A	B	C	A	B	C	A	B	C
Wye College	H	0.71	0.90	0.38	0.58	0.92	0.92	0.77	0.94	0.66	0.94	0.34	0.56
Wye College	L	0.50	0.50	0.07	0.71	0.96	0.88	0.88	0.98	0.67	0.85	0.24	0.50
Dene Park	H	0.79	0.52	0.21	0.83	0.86	0.81	0.72	0.92	0.62	0.83	0.76	0.40
Hadlow College	M	0.35	0.76	0.71	0.53	0.83	0.31	0.88	0.90	0.55	0.30	0.72	0.69
Hants College	L	0.28	0.21	0.25	0.48	0.50	0.27	0.31	0.23	0.04	0.17	0.14	0.02

When $r \leqslant 0.5$ the linear regression accounts for only a minor portion of the variance; when $r = 0.7$ nearly half the variance has been accounted for increasing to 80% when $r = 0.9$.

Correlation analysis is well known for giving results which are strongly conditioned by the data used. For a small data sample such as this, very high correlations are required to satisfy the statistician that a linear relationship exists. In this analysis where the data is of a subjective nature, the high correlations necessary to prove the relationship will not be achieved even though, instinctively, one feels that this dependence does exist. One should not be deterred therefore by the statistics which have shown only 40% of the correlations to be significant eg. if ten years of data where available a value of $r > 0.632$ would be statistically significant.

The difference in days between predicted and actual values rounded to the nearest half day and omitting anomalous values are given in Appendix 7. The monthly estimates generally agree to within $\pm$ 3 days of the actual while the corresponding Feb-May figure is $\pm$ 10 days (and is therefore comparable to Smith's estimates).

Records for 1979 were used as an independent check and the errors found are shown in Table 4. (data for Hadlow College was not available after 1978).

Table 4

Monthly errors** between predicted work day totals and actual totals during 1979

\+ values indicate an over-estimated by the regression formulae
\- " " " under- " " " " " "

Station	Soil	Error (days) Feb			Mar			Apr			May		
		A	B	C	A	B	C	A	B	C	A	B	C
Wye College	H	0.5	5.0	18.5*	-1.0	-1.0	3.0	7.0*	-4.5	-3.0	-3.0	4.0	0.0
Wye College	L	0.5	5.5	12.0*	-1.5	-1.0	-2.0	9.5*	0.5	-5.0	-5.0	4.0	0.5
Dene Park	H	2.0	4.5	-1.5	-6.0	-3.0	-4.0	6.0	12.5*	9.5*	-4.5	-6.0	-6.5
Hants College	L	1.0	4.0	-3.0	-5.0	-8.0	-8.0	2.0	0.5	-5.0	no	data	

* 'anomalous' values
** all errors are rounded up to the nearest half day.

Table 4 indicates that most predictions agreed to within $\pm$ 5 days.

Discussion

The formulae for March and April returned the best predictions, particularly those in Group B. The relatively poor values for February and May are probably due to the slight gradients of the regression lines (a regression line parallel to the axis has zero correlation). This explains why small errors may be obtained when correlations are low (compare the results for Hants College during March and May in Group B).

The use of daily rainfall values does not allow the time at which rain fell to be considered. Rain falling during the daytime, for example, is likely to be more detrimental to work than an equivalent overnight fall so perhaps a modification to this technique could be to use daylight wet days summed over the month instead of just wet days (the paucity of the meteorological network however is such that information of this kind is not readily available).

The use of this technique for farm planning is severely restricted because the regression formulae could only be derived for individual stations. It was hoped to be able to obtain equations for individual months for light, medium and heavy soils and then to test these with data for other regions. As it stands, however, no predictions can be made for farms other than the 'parent' farm although if more data becomes available, this situation may be rectified.

Acknowledgement

I am indebted to Mr P J James and colleagues of the Farm Management Dept., MAFF, Coley Park for providing the initial data and for the many useful contributions made during this analysis.

C P ROE
Meteorological Office,
MAFF, Reading

December 1980.

References

1. Smith, C.V. (1966)
Agricultural memorandum no 168. "Machinery work days - spring cultivation".

2. Smith, C.V. (1967)
Agricultural memorandum no. 182. "Machinery work-day criteria - a trial on independent data".

3. Smith, C.V. (1968)
Agricultural memorandum no. 211. "Machinery work days - simplified criteria".

4. Westlake, G.H. (1977)
"Determination of research priorities at ADAS experimental centres".
M. Phil. thesis. University of Nottingham.

Appendix 1

Light Land

1. A dry day

A dry day is one with rainfal $\leq$ .09 inches.

2. The initial start to the seasons work

2. (a) The day when work begins shall be dry.
The day when work begins shall be one on which the ground is not frozen.

2. (b) When, on andafter February 7th a total of 7 dry days has accumulated (independently of the occurrence of intervening wet days) work may begin after a sequence of 3 further consecutive dry days.

3. The termination of work

3. (a) In February to mid-April, rainfall $\leq$ .19 inches in one day does not interfere with a run of work, such days are counted as work days.
On and after April 17th, rainfall $\leq$ .29 inches in one day does not interfere with a run of work.
Such days are counted as work days.

3. (b) In February to mid-April a run of work is ended by a rainfall $\geq$ .20 inches in one day. Such days are not counted as work days.
On and after April 17th a run of work is ended by a rainfall $\geq$ .30 inches in one day. Such days are not counted as work days.

4. The recommencement of work

4. (a) The day when work begins again after a wet interlude shall be dry.

4. (b) In February to mid April, a days rainfall of $\leq$ .19 inches does not interfere with a run of work.

With a days rainfall in the range .20 to .39 inches work may being again after 1 dry day.
With a days rainfall in the range .40 to .59 inches work may begin again after 2 dry days
With a days rainfall in the range $\geq$.60 inches work may begin again after 3 dry days

On and after April 17th a days rainfall $\leq$.29 inches does not interfere with a run of work.

In this period,

With a days rainfall in the range .30 to .49 inches work may begin after 1 dry day
" " " " " " " $\geq$.50 inches " " " " 2 dry day

4. (c) The dry days specified in section 4. (b) before work can begin again need not be consecutive. If after the termination of work subsequent days are wet, then the interval during which no work is possible is, of course, extended. In such a wet interlude,

each successive day is taken as the starting point for the recalculation of the number of dry days required (according to the stipulations of section 4 (b)) before work can begin again. Since such counts may in fact overlap, the day adopted for the recommencement of work is that furthest in time from the day when rainfall stopped work.

4. (d) If the wet interlude (when no work is possible according to the criteria above) extends over a period of 5 or more consecutive days, then the following conditions must be met before work can begin again.
In February to mid April 3 consecutive dry days must occur before work can recommence.
On and after April 17th, 2 consecutive dry days must occur before work can recommence.

Appendix 2

GROUPING OF AVAILABLE WORK DAYS

JOB GROUP 1

i) Ploughing
ii) Subsoiling
iii) Chisel Ploughing
iv) Sugar beet harvesting

JOB GROUP 2

i) Potato Harvesting

JOB GROUP 3

i) Springtime cultivation
ii) Dutch harrowing
iii) Discing
iv) Stubble cultivations
v) Tractor hoeing
vi) Direct drilling (cereals etc.)
vii) Direct drilling (sugar beet)
viii) Potato planting
ix) Fertiliser spreading

JOB GROUP 4

i) Spraying

JOB GROUP 5

i) Light harrowing
ii) Rolling
iii) Drilling (not direct drilling)
iv) Undersowing grass seeds

JOB GROUP 6

i) Precision drilling

JOB GROUP 7

i) Bale carting

GROUPING OF AVAILABLE WORK DAYS

JOB GROUP 8

i) Combine harvesting
ii) Baling straw
iii) Straw burning

NB. Available work days for jobs not included in this list eg. grassland conservation, have not yet been determined. Where jobs have the same criteria as those above the same available day figures can be used.

APPENDIX 3

CRITERIA FOR ASSESSING AVAILABLE WORK DAYS

JOB GROUP 1

i) Work day = < 6 mm rainfall

JOB GROUP 2

i) Work day = < 5 mm rainfall.

ii) Non-work day = 5-12.5 mm rainfall.

iii) " " "
with 1 days delay = > 12.5 mm rainfall.

JOB GROUP 3

A. Beginning of October to Mid-April

The day when work begins shall be a drying day (≥ Force 2 on the Beaufort scale with no (0 mm) rainfall.

Thereafter -

i) Work day = < 5 mm rainfall.

ii) Delay of 1 dry day = 5-10 mm rainfall

iii) Delay of 2 dry days = 10-15 mm rainfall.

iv) Delay of 3 dry days = > 15 mm rainfall.

In all cases -

i) Ground must not be frozen at 10 cm

ii) There must be < 12.5 mm snow cover.

B. Mid-April to end of September

The day when work begins shall be a drying day (≥ Force 2 on the Beaufort scale) with no (0 mm) rainfall).

Thereafter -

i) Work day = < 7.5 mm rainfall.

ii) Delay of 1 dry day = 7.5 - 12.5 mm rainfall.

iii) Delay of 2 dry days = > 12.5 mm rainfall.

JOB GROUP 4

i) Ground conditions similar to group 3.

ii) Wind speed $\leq$ 10 knots.

JOB GROUP 5

i) Ground conditions similar to group 3 but with the first day of each work period excluded.

JOB GROUP 6

i) Ground conditions similar to group 5 but work day = 0 mm rainfall.

JOB GROUP 7

i) Work day = 0-2.5 mm rainfall.

ii) $\frac{1}{2}$ work day = 2.5 - 5 mm rainfall.

iii) Non-work day = $>$ 5 mm rainfall.

JOB GROUP 8

i) Work day = 0 mm rainfall.

ii) $\frac{1}{2}$ work day = 0-2.5 mm rainfall.

iii) Non work day = $>$ 2.5 mm rainfall.

Provided: 1 Completely dry day (0 mm) since $\geq$ 5 mm rainfall.

2 Completely dry days (0 mm) since $\geq$ 7.5 mm rainfall.

NOTE

The effects of a run of wet or damp days and the drying effects of wind have been taken into consideration arbitrarily as appropriate.

Appendix 4

MAFF - AGRICULTURAL DEVELOPMENT AND ADVISORY SERVICE - SE REGION

Days Available for Field Work

Centre Wye

Heavy Land

Instructions

Mark col (a) (b) or (c) as appropriate (✓ for full day x for ½ day)
Record to show when work is possible on the land, not necessarily when work is done
Include Sundays and holidays

MONTH	MARCH 79			APRIL 79		
	ESSENTIAL SEASONAL WORK POSSIBLE		OTHER FIELD WORK POSSIBLE	ESSENTIAL SEASONAL WORK POSSIBLE		OTHER FIELD WORK POSSIBLE
DAY	Requiring fine weather eg Spraying Hay making Combining (a)	More tolerant of conditions eg cults Fert. appn. Straw/hay cart. Silage making (b)	eg Ploughing (c)	Requiring fine weather eg Spraying Hay making Combining (a)	More tolerant of conditions eg cults. Fert. appn. Straw/hay cart. Silage making (b)	eg Ploughing (c)
1						✓
2						✓
3						
4						
5	✓	✓				
6	x	✓	x			
7	x	✓	✓		x	✓
8		✓	✓		✓	✓
9			✓	✓	✓	✓
10			✓	✓	✓	✓
11			✓	✓	✓	✓
12			✓		✓	✓
13					✓	✓
14					✓	✓
15					✓	✓
16					✓	✓
17			✓		✓	✓
18		✓	✓		✓	✓
19		✓	✓		✓	✓
20	✓	✓	✓		✓	✓
21	✓	✓	✓		✓	✓
22					✓	✓
23			x		✓	✓
24					✓	✓
25					✓	✓
26			x		✓	✓
27					✓	✓
28					✓	✓
29					✓	✓
30					✓	✓
31						
Rainfall in month				Rainfall in month		

Please return completed form to Farm Management Unit, ADAS, [illegible], Coley Park, Reading [illegible]

Appendix 5

Data has been recorded at the following centres; those asterisked have incomplete records and have not been used:

* Aylesbury College of Further Education, Stoke Mandeville.
* Berkshire College of Agriculture, Burchett's Green.

Dene Park Farm, Tonbridge, Kent.

Hadlow College, Tonbridge, Kent.

Hants College of Agriculture, Sparsholt.

Home Farm, Goodward Estate, Goodwood.

* Manor Farms and Stud, Alresford.
* Surrey College of Agriculture, Merrist Wood.
* Oxford County Teaching Farm, Tiddington.
* West Sussex School of Agriculture, Pulborough.

Wye College, Wye.

The actual monthly values, 1974-79, for the five stations used in the analysis are presented below.

1. Wye College, heavy land.

Year	February			March			April			May		
	A	B	C	A	B	C	A	B	C	A	B	C
1974	0	0	0	11	16	27	29	29½	30	30½	30½	31
1975	3	16	22	0	0	4½	8½	12	12	13	27	27
1976	2	22	29	20½	23½	31	28	29	30	28	29½	30½
1977	1	4	20	3	9	25	14½	26	29	18	26	31
1978	0	½	19	4½	21½	31	3½	21½	28½	20	22½	31
1979	½	1	2½	4	8	12½	3	23½	25	8½	19	27

2. Wye College, light land

Year	February			March			April			May		
	A	B	C	A	B	C	A	B	C	A	B	C
1974	0	0	25	12	20	31	29	29½	30	30½	30½	31
1975	10	11	20	0	3	17	9	14½	17½	13	28	28½
1976	4	23½	29	20½	24½	31	27½	29	30	28	29½	30½
1977	3	11½	21	3	16½	30	17	26	30	19	25	31
1978	0	5½	25	8	23	31	7½	20½	28½	13½	23½	31
1979	2	3	12	5	12	26	2	19	29	8½	20	28

3. Dene Park Farm, heavy land

Year	February			March			April			May		
	A	B	C	A	B	C	A	B	C	A	B	C
1974	11½	19	25½	18½	27	29½	28½	30	30	28	30½	31
1975	20	21	21	5½	12½	12½	21½	22½	24½	24½	28	29
1976	17½	26	27½	24	30½	30½	26½	27½	29½	27	29½	31
1977	10½	21	13½	20	28	29	21½	27	29½	21½	25	28
1978	8½	19	11	14½	24½	21½	14½	22½	16	23½	26½	22
1979	12½	17	19	11	15½	16	11½	10	11	22½	28	28

4. Hadlow College, medium land

Year	February			March			April			May		
	A	B	C	A	B	C	A	B	C	A	B	C
1974	1	1½	14½	9½	14	27	24	27	28½	22	29½	31
1975	0	7½	23	0	1	25½	10	13½	27	21½	25	29
1976	12½	17½	29	18½	23½	31	27	30	30	20	26½	31
1977	0	0	17	4	15	25	13	26½	30	14½	21½	29
1978	0	0	10½	0	13½	31	7½	15½	24	18	24	27
1979	←			no data					→	18½	21½	30

5. Hants College, light land

Year	February			March			April			May		
	A	B	C	A	B	C	A	B	C	A	B	C
1974	0	15	24	13	28	28	29	30	30	21	30	30
1975	0	16	27	0	11	15	14	20	26	13	28	30
1976	4	16	28	16	27	28	20	30	30	12	31	31
1977	0	9	15	11	17	25	3	10	11	21	30	30
1978	0	0	0	3	24	25	6	19	22	25	26	29
1979	0	10	27	5	18	26	11	21	30	← no data →		

Appendix 6

Linear Regression Equations for groups A, B and C for the months February to May

Equations are of the form Y = A + BX where

Y = predicted monthly work day total

X = monthly factor

A and B are constants

Group A

Station	Soil	February	March	April	May
Wye College	H	Y = 2.82 - 0.06X	Y = 13.48 - 0.19X	Y = 27.02 - 0.92X	Y = 30.96 - 0.83X
Wye College	L	Y = 7.72 - 0.16X	Y = 14.90 - 0.20X	Y = 27.63 - 0.87X	Y = 30.43 - 0.88X
Dene Park	H	Y = 19.34 - 0.19X	Y = 22.18 - 0.26X	Y = 28.21 - 0.61X	Y = 28.21 - 0.35X
Hadlow College	M	Y = 6.96 - 0.14X	Y = 11.47 - 0.23X	Y = 26.34 - 1.07X	Y = 21.94 - 0.41X
Hants College	L	Y = 2.01 - 0.03X	Y = 16.06 - 0.42X	Y = 25.30 - 0.78X	Y = 29.73 - 0.83X

Group B

Station	Soil	February	March	April	May
Wye College	H	Y = 22.58 - 0.51X	Y = 22.43 - 0.28X	Y = 30.59 - 0.62X	Y = 29.46 - 0.22X
Wye College	L	Y = 19.63 - 0.34X	Y = 25.14 - 0.25X	Y = 30.34 - 0.58X	Y = 29.17 - 0.17X
Dene Park	H	Y = 23.89 - 0.09X	Y = 30.39 - 0.27X	Y = 29.82 - 0.42X	Y = 30.56 - 0.29X
Hadlow College	M	Y = 13.78 - 0.28X	Y = 19.95 - 0.30X	Y = 31.19 - 0.93X	Y = 28.81 - 0.37X
Hants College	L	Y = 16.93 - 0.08X	Y = 28.02 - 0.28X	Y = 30.71 - 0.58X	Y = 30.56 - 0.14X

Group C

Station	Soil	February	March	April	May
Wye College	H	Y = 26.97 - 0.18X	Y = 33.02 - 0.31X	Y = 32.19 - 0.55X	Y = 31.78 - 0.15X
Wye College	L	Y = 25.40 - 0.05X	Y = 33.27 - 0.17X	Y = 31.79 - 0.42X	Y = 31.39 - 0.09X
Dene Park	H	Y = 25.59 - 0.30X	Y = 30.42 - 0.28X	Y = 31.70 - 0.62X	Y = 31.42 - 0.34X
Hadlow College	M	Y = 26.83 - 0.27X	Y = 29.37 - 0.07X	Y = 30.18 - 0.24X	Y = 31.32 - 0.20X
Hants College	L	Y = 29.05 - 0.14X	Y = 27.83 - 0.15X	Y = 30.27 - 0.32X	Y = 30.19 - 0.02X

Appendix 7

Monthly differences (days) between predicted work day totals (using linear regression formulae) and actual totals

\+ values indicate over estimates by the formulae

\- " " under " " " "

1) Wye College Heavy Soil

Year	GROUP A					GROUP B					GROUP C				
	Feb	Mar	Apr	May	Feb-May	Feb	Mar	Apr	May	Feb-May	Feb	Mar	Apr	May	Feb-May
1974	0.5	0.0	-3.0	-1.5	-4.0	2.0	3.0	0.5	-1.5	4.0	/	2.5	0.0	0.0	/
75	-1.0	0.0	-6.0	-1.0	-8.0	1.5	0.0	1.5	-2.5	0.5	3.0	2.0	5.0	1.5	10.0
76	0.5	-7.5	-2.5	0.5	-9.0	-2.0	-1.5	0.5	-0.5	-3.5	-3.0	1.0	0.0	0.5	-3.5
77	-1.0	3.0	4.5	2.5	9.0	-4.0	3.0	-1.0	0.5	-1.5	-1.0	-4.0	-1.5	-1.0	-7.5
78	0.5	6.5	6.5	0.0	13.5	3.0	-3.0	-2.5	4.0	1.5	1.0	-2.5	-6.5	-1.0	-9.0

2) Wye College Light Soil

Year	GROUP A					GROUP B					GROUP C				
	Feb	Mar	Apr	May	Feb-May	Feb	Mar	Apr	May	Feb-May	Feb	Mar	Apr	May	Feb-May
1974	1.5	0.5	-2.0	-2.5	-2.5	6.0	2.0	0.5	-2.0	7.0	-1.5	0.0	0.0	0.0	-1.5
75	-4.0	0.0	-3.5	-3.0	-10.5	5.5	1.0	1.0	-2.5	5.0	5.0	2.0	3.5	1.0	11.5
76	3.0	-6.0	-1.0	0.0	-4.0	-5.5	0.0	0.5	-1.0	-6.0	-4.0	0.0	0.0	0.5	-3.5
77	-2.5	-4.0	3.0	0.5	5.0	-7.0	-1.0	-0.5	2.0	-11.0	2.0	-3.5	2.0	-0.5	-4.0
78	1.0	4.0	4.0	5.0	14.0	1.5	-1.5	-1.0	3.5	2.5	-1.5	0.0	-4.5	-1.0	-7.0

3) Dene Park Heavy Soil

Year	GROUP A					GROUP B					GROUP C				
	Feb	Mar	Apr	May	Feb-May	Feb	Mar	Apr	May	Feb-May	Feb	Mar	Apr	May	Feb-May
1974	-2.0	2.5	-1.0	-0.5	-1.0	0.5	2.5	-1.0	-1.0	1.0	/	0.0	1.0	0.0	/
75	-2.0	0.5	-4.0	-1.5	-7.0	2.5	1.0	0.0	-3.0	0.5	2.5	0.5	-3.5	-2.5	-3.0
76	1.0	-2.0	0.0	0.5	-0.5	-2.5	-0.5	1.5	-1.0	-2.5	-3.5	0.5	0.5	-0.5	-3.0
77	-0.5	-4.0	1.5	1.5	-1.5	-1.5	-4.0	-1.0	-1.5	-8.0	-2.5	-4.5	-3.0	-1.5	-11.5
78	3.5	2.5	3.5	0.0	9.5	-1.5	1.0	0.5	4.5	4.5	3.0	4.5	5.5	5.0	18.0

4) Hadlow College — Medium Soil

Year	GROUP A					GROUP B					GROUP C				
	Feb	Mar	Apr	May	Feb-May	Feb	Mar	Apr	May	Feb-May	Feb	Mar	Apr	May	Feb-May
1974	-1.0	1.0	1.0	-0.5	0.5	-1.5	5.0	3.0	-1.0	5.5	-1.5	2.0	1.5	0.0	2.0
75	6.0	0.0	-2.5	/	/	4.5	0.5	1.0	-1.5	4.5	2.0	-0.5	-1.0	-0.5	0.0
76	-6.0	-7.0	-3.5	1.0	-15.5	-5.0	-4.0	-1.0	1.5	-8.5	-3.5	-1.5	-0.5	0.0	-5.5
77	0.0	2.0	4.0	1.5	7.5	0.0	-2.5	-3.5	1.5	4.5	-3.5	2.5	-2.0	-0.5	-3.5
78	1.5	7.0	1.0	-1.5	8.0	2.5	1.0	0.0	0.0	3.5	5.5	-3.0	2.0	1.5	6.0

5) Hants College — Light Soil

Year	GROUP A					GROUP B					GROUP C				
	Feb	Mar	Apr	May	Feb-May	Feb	Mar	Apr	May	Feb-May	Feb	Mar	Apr	May	Feb-May
1974	0.0	1.0	-4.5	2.0	-1.5	-3.0	-1.5	0.0	-0.5	-5.0	-3.5	-1.0	0.0	0.0	-4.5
75	1.5	2.5	-5.0	/	/	0.5	8.0	-1.0	-2.0	5.5	1.5	8.0	-2.5	0.0	7.0
76	-2.5	-1.0	4.0	11.5	12.0	0.0	0.5	-0.5	-1.5	-1.5	-0.5	-1.5	-0.5	-1.0	-3.5
77	0.0	/	/	1.0	/	1.5	0.5	/	-0.5	/	3.0	-3.5	/	0.0	/
78	0.5	-2.5	5.5	-4.0	-0.5	/	-6.5	1.5	0.5	/	/	2.5	2.5	1.0	/

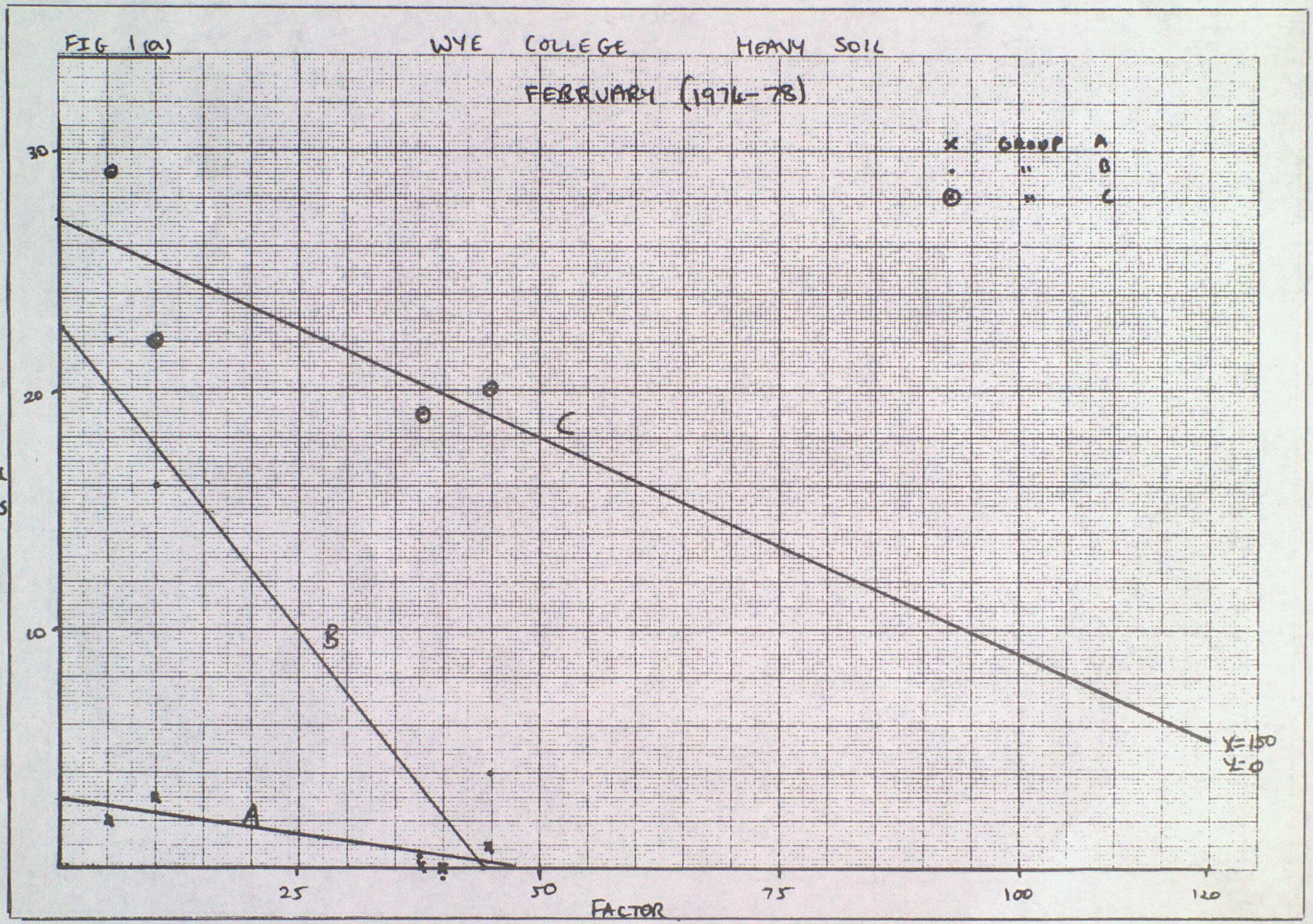
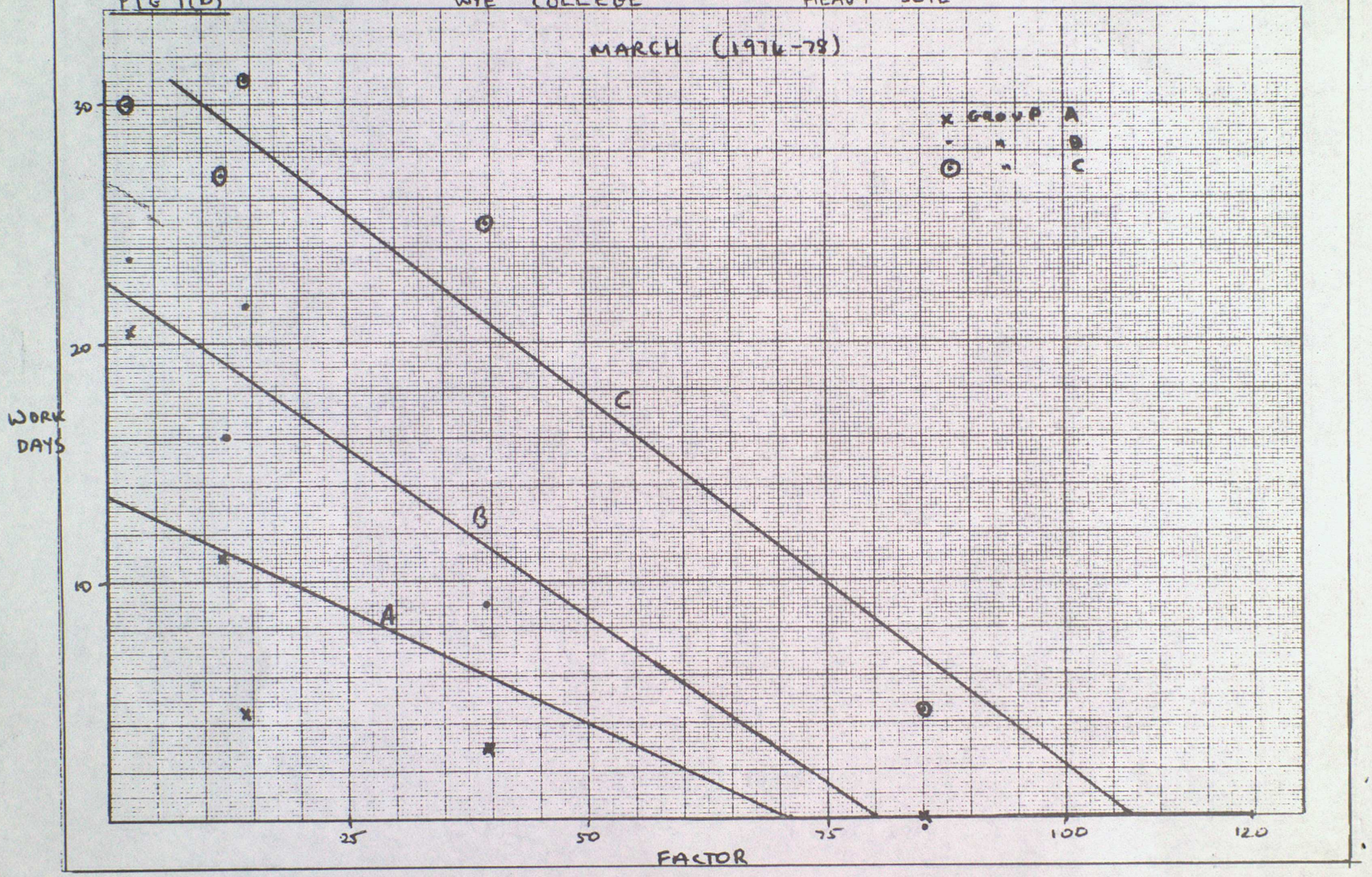


FIG 1(a)
WYE COLLEGE
HEAVY SOIL
FEBRUARY (1976-78)
x Group A
• " B
⊙ " C
30
20
10
WORK DAYS
A
B
C
Y=150
Y=0
25
50
75
100
120
FACTOR

FIG 1(b) WYE COLLEGE HEAVY SOIL

MARCH (1976-78)



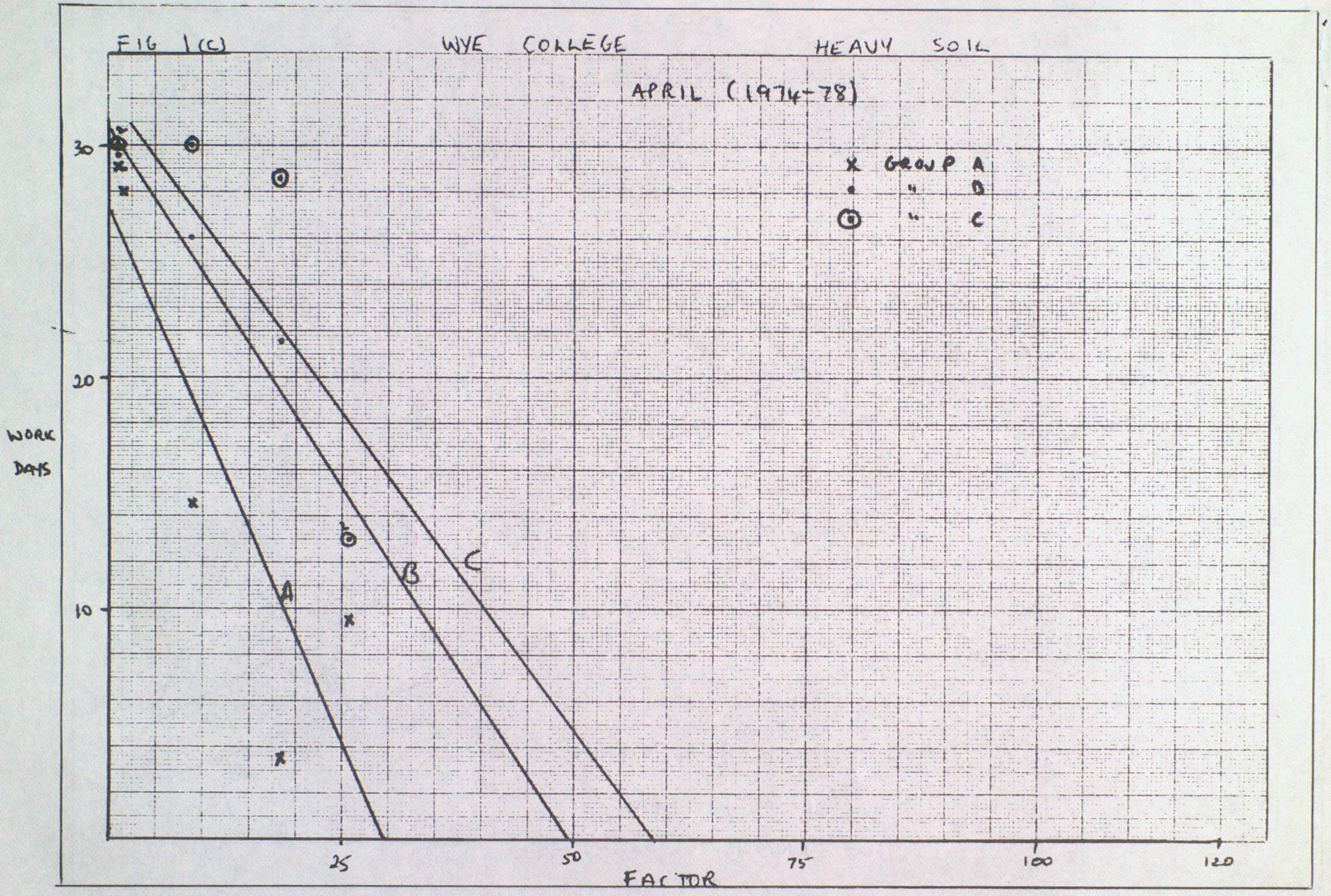


FIG 1 (C)
WYE COLLEGE
HEAVY SOIL
APRIL (1974-78)
X GROUP A
• " B
⊙ " C
30
20
10
WORK DAYS
A
B
C
25
50
75
100
120
FACTOR

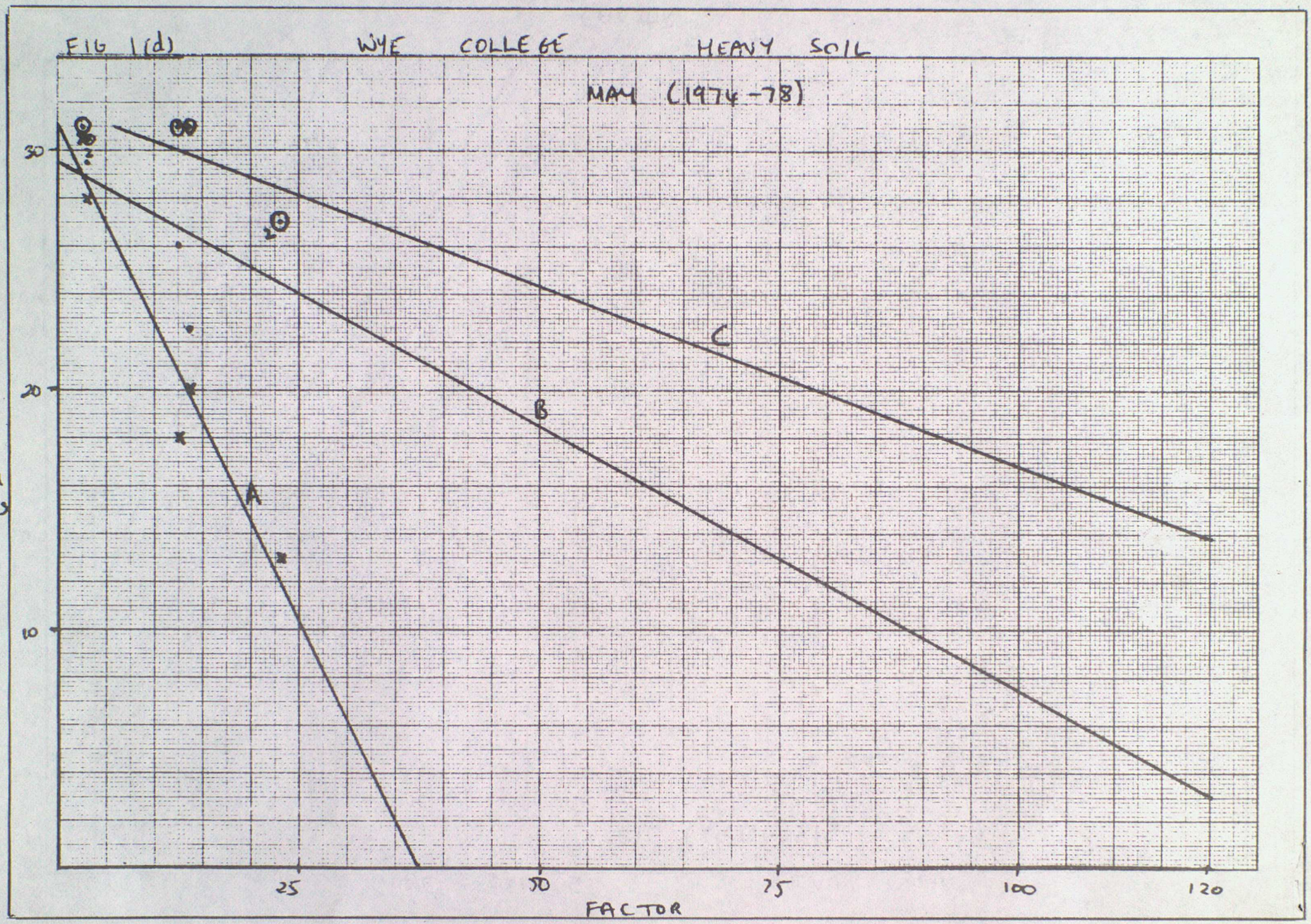


FIG 1(d)
WYE COLLEGE
HEAVY SOIL
MAY (1974-78)
30
20
10
WORK DAYS
A
B
C
25
50
75
100
120
FACTOR